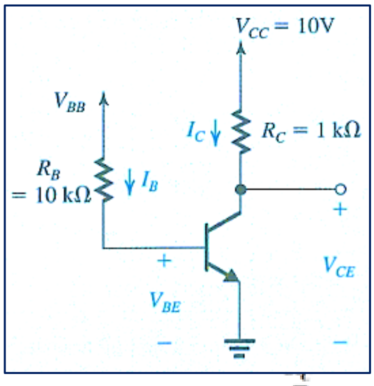
Tutoriel Work of Chapter 2: Bipolar Junction Transistor

Exercise N°1

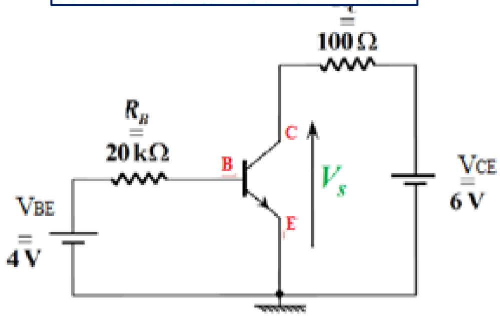
For a circuit shown in Figure, we need the value of V_{BB} for the transistor to operate in:

1- In the active mode with Vce= 5V.
2- At the edge of saturation.
3- Deep in saturation with β_{forced}=10



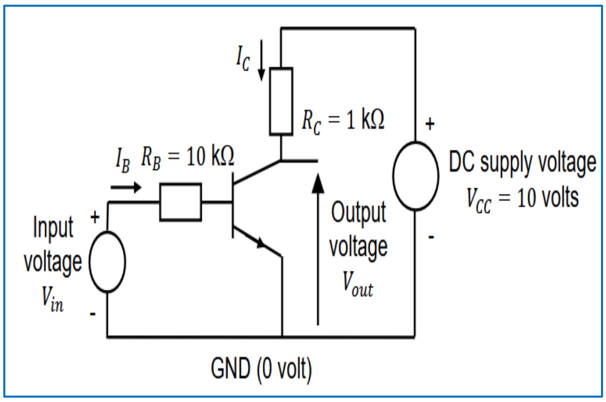
Exercice N°2 :

Determine the currents I_B and I_C and the voltages V_S and V_{CB} in the transistor circuit shown in figure. Assume that the transistor operates in active mode and that the currect gain is equal 50.



Exercise N°3

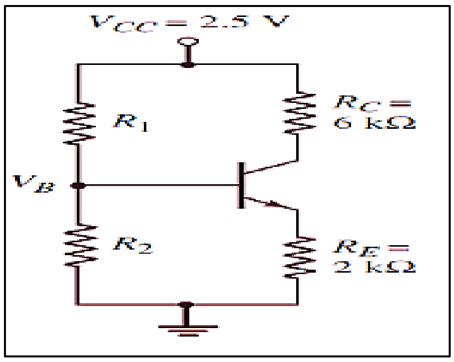
Consider the circuit depicted below. The NPN BJT has a forward current gain $\beta_F = 100$. Find the DC voltage transfer characteristic for this circuit. In other words, for each value of the input voltage V_{in} ranging from 0 to V_{CC} = 10 volts, we want to determine the corresponding output voltage $Vout$.



Exercise N°4

For the transistor in the adjacent diagram, assume $\beta = 120$.

1- Identify the circuit elements so that: $I_{C_Q} = 0.15mA$ and $R_{Th} = 200k\Omega$.
2- Calculate the value of V_{CE_Q}.

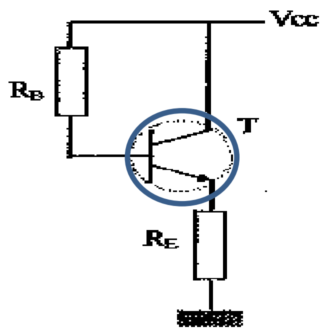


Exercise N°5

Q-point

The operating point $Q(8V, 5mA)$ is in the middle of the DC load line.
Calculate: V_{CC}, R_B and R_E

Given:$V_{BE} = 0.5V$ and $\beta = 100$



Exercise N°6

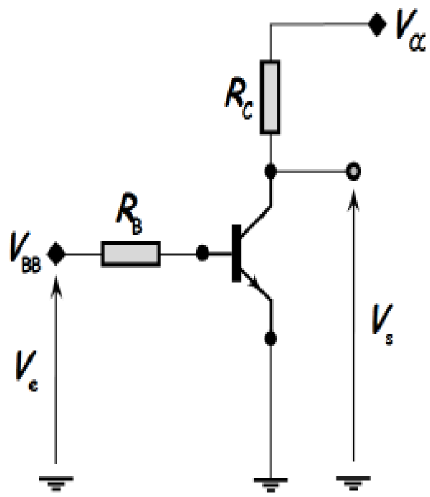
Consider the circuit shown in the figure where:

$V_{CC} = 5V$, $\beta = 120$; $V_{BE} = 0.7V$, $V_{CEsat} = 0.2V$,$R_B = 150K\Omega$ and $R_C = 5K\Omega$. V_{BB} can take values from 0V to 5V

1- Determine the value of V_{BB} at which the transistor switches from blocking to active operation. Find the values of the transistor currents and voltages for $V_{BB} = 1.5V$.

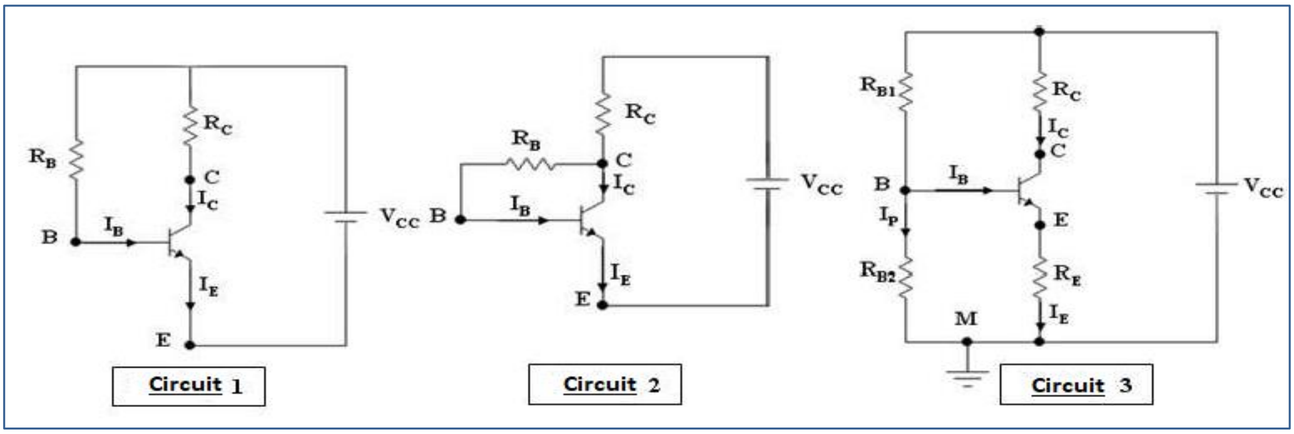
2- Determine the value of VBB at which the transistor enters in the saturation state. Find the values of the transistor currents and voltages for V_{BB}=3V and calculate the value of the current gain.

3- Draw the graph $I_C = f(V_{BB})$ and the voltage transfer characteristic $Vs = f(Ve)$.



Exercise N° 7

A silicon NPN transistor is used in the following three circuits:



1- Give the names of biasing methods expressed by its circuits.
2- Calculate the necessary polarization elements. For each circuit, the operating point (polarization) must be as follows: $V_{CE_0} = 5$ V, $I_{C0} = 1$mA , $V_{CC} = 10$V, β $= 100$ and $V_{BE_0} = 0.7$V. For the circuit 3, we set $I_p = 100\mu$A and $R_E = 1k\Omega$.

Exercise N°8

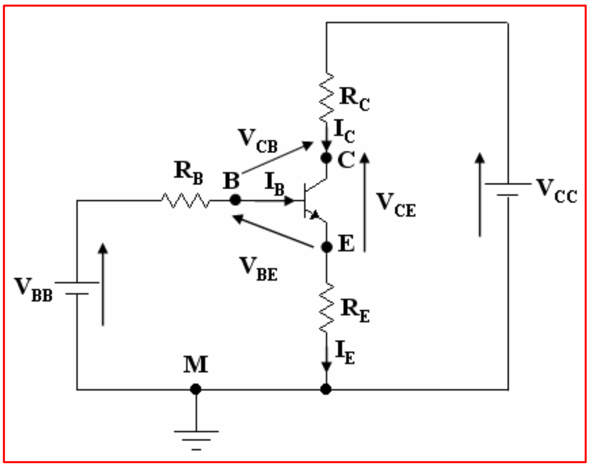
Consider the circuit shown in the following figure:

1- Calculate the silent points (Quiescent point: Q-point) (I_B, I_C *and* V_{CE}).

2- Express and plot the straight lines: $I_C = f\ (V_{CE})$ and $I_B = f\ (V_{BE})$.

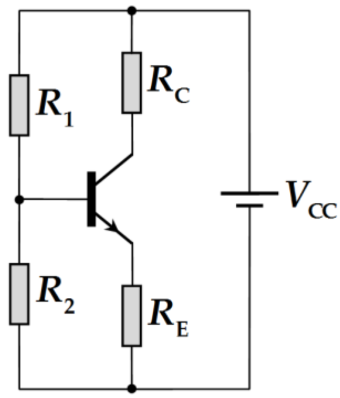
3- Represent the Q-points on their straight lines.

Given: β=180, $V_{BB} = 5\ V$, $V_{CC} = 10\ V$, $V_{BE} = 0.6$ V, $R_B = 10\ k\Omega$, $R_C = R_E = 100\ \Omega$.



Exercise N°9

The transistor, in the circuit shown opposite, is defined by its characteristics given on the attached plot sheet.



We give: V_{CC} = 18V, R_1 = 268.2kΩ, R_2 = 22.62kΩ, R_C = 5.86kΩ, and R_E = 140Ω.

1/ Find graphically the static current gain, β, of the transistor.

2/ Determine the equation of the static drive line.

3/ Plot the static drive line on the input characteristic of the transistor. Deduce I_{B_Q} and V_{BE_Q} (coordinates of the input operating point Q_E).

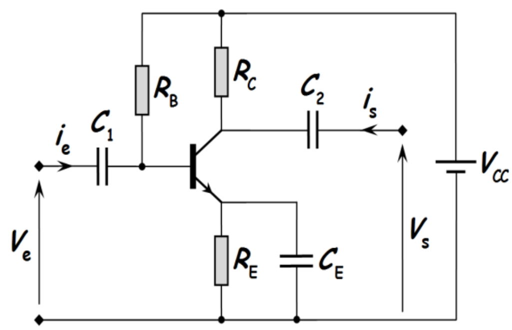
4/ Find the equation of the static load line.

5/ Plot the static load line on the transistor output characteristics. Deduce I_{C_Q} and V_{CE_Q} (coordinates of the output operating point Q).

Exercise N°10

Consider the circuit shown in the figure opposite with :

V_{CC} = 11V, R_C = 2.7kΩ, R_E = 390Ω, β = 135, h_{11} = 2.7kΩ, h_{12} =. h_{12} = 0.



☐ **Static analysis:**

Given V_{BE} = 0.7V and V_C = 5.6V (voltage between the collector and the ground).

a/ Find the value of R_B .

b/ Calculate the values of I_{C_0} and V_{CE_0}

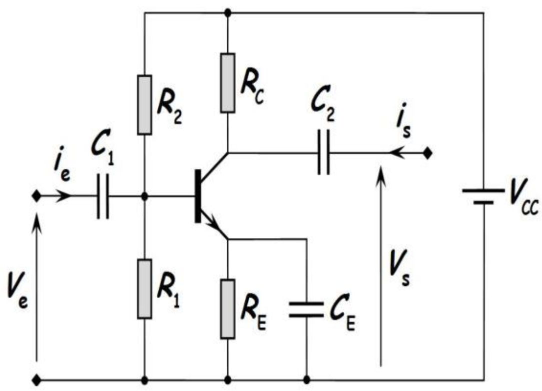
☐ **Dynamic analysis:**

a/ Draw the equivalent circuit diagram. **b/** Find the input resistance. **c/** Determine the voltage gain.

Exercise N°11

Let's consider the amplifier as in the figure on the right.

Where: $I_C=I_E=2.8mA$, $V_{BE}=0.6V$, $V_{CC}=24V$, $h_{11}\ll R_1//R_2$, $h_{12}=h_{22}=0$, $h_{21}=\beta=100$.

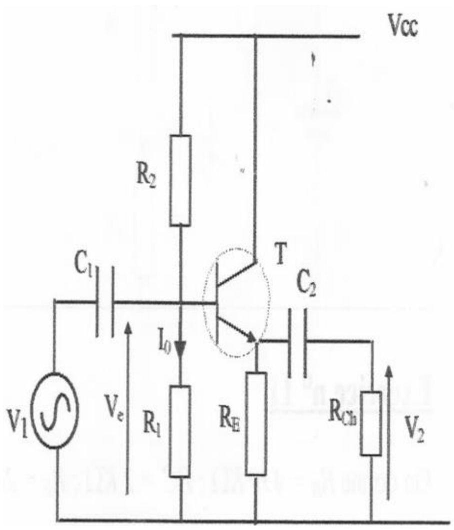


1. Given that the amplifier has a no-load voltage gain of **-220**, an input impedance of **900 Ω,** and an operating point in the middle of the static load line, calculate the values of the resistors R_C and R_E.
2. Find R_1 and R_2 if $R_B=10R_E$ where $R_B=R_1//R_2$.
3. An R_L load is placed between the collector and the ground at the output of the circuit.
   a. Determine the gain in current.
   b. Determine the output resistance.

Exercise N°12

In this circuit $h_{11} = 100\Omega,\ \beta = 150\ , h_{22}^{-1}\ infinite$

Operating point $V_{CE}\ = 7.5V,\ I_C = 75mA\ , V_{BE} =\ 700mV$



1- Static study (DC study)

For $V_{CC} = 15V$

1- What type of amplifier is it?
2- Give the role of the elements $(R_1, R_2, R_E, C_1, C_2, V_{CC})$
3- Calculate R_E
4- Calculate $R_1$and Re knowing that $I_0 = 10.I_B$

2- Dynamic study (for medium frequencies)

5- Draw the equivalent circuit diagram for an alternating signal
6- Calculate the voltage amplification$A_v = V_2/V_1$ ($Rch\ = 100\Omega$)
7- Calculate Re (input resistance) between B and M and between the terminals of V_1
8- Calculate the current amplification $A_i = i_2/i_1$